



SMART POWER MONITORING & ANALYSIS

Kailash Tambe¹ | Tanmay Sinnarkar¹ | Malhar Inamdar¹ | Archit Jaiswal¹ | Govind Bhashkar¹

¹ Department of Computer Engineering, MIT College of Engineering, Savitribai Phule Pune University, Pune, India

ABSTRACT

Mostly in college campus, appliances like light and fan are manually controlled which leads to power wastage. They are left ON even if there is no usage. Our aim is to develop a way to keep a track of each and every appliance in the college and monitor all appliance energy consumption parameters on a handheld Android device. By making a smart automated controlling system for appliances we can save the power by huge amount. Providing a solution for preventing the wastage of power in a comfortable and cost effective way. This System will give real-time feedback on the energy usage and what it costs and also will provide with direct comparison between the manual and the automated system in a graph format and according to the statistics obtained actions will be taken. This system also gives statistical information and will help generate a chart of power consumed during various period of time (hourly, daily, monthly, yearly) and also on the departmental basis of campus.

KEYWORDS: IOT IoCare Module, Cloud Server, Data Analysis, Sampling, Data Comparison.

INTRODUCTION

PROBLEM STATEMENT :

Most conventional prepaid power meters currently installed in households only display the total real time usage of its power and the amount of electricity available. There is no way to see what the days, weeks or months consumption was on these meters and often these power meters are placed in an inconvenient location which makes regular viewing somewhat difficult. These power meters also lack the ability to monitor appliances individually; thus hiding vital information about individual appliances.

GOALS AND OBJECTIVES :

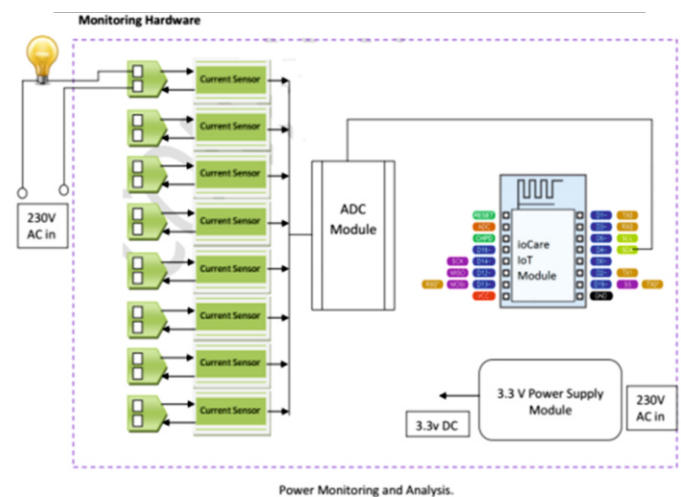
The objective of this project is to significantly lower the electricity bill and consumption by at least 30% to 40%. To obtain statistical information about billing and electricity consumption in macro as well as mini point of view. More accurate bills mean the end of estimated bills, and the end of overpaying (or underpaying) for energy. Better oversight and management of energy use with a real-time data display in home. The above objective will be considered successful only if the following criteria are met :

- Wireless communication between nodes and gateway.
 - Correct measurements of Voltage, Current and Power.
 - A working user interface on the gateway with a display and menu.
 - Reliable Wireless communication between gateway and remote meter nodes.
- MATH MODEL:**
- System Description :**
- Input: reading from each load
 - Output: analyzed data
 - Identify data structures, classes, divide and conquer strategies to exploit distributed/parallel/concurrent processing, constraints.
 - Functions: Identify Objects, Morphisms, Overloading in functions, Functional relations
 - Mathematical formulation if possible
 - Success Conditions: substantial amount of power saved
 - Failure Conditions: won't accept reading, take incorrect reading, invalid data format, wrong data analysis

HARDWARE:

We will be using a current sensor to measure the high voltage AC current. Output of this sensor will be processed to match ADC range of microcontroller and then converted to send it to central cloud server instance for analysis. ioCare IoT Module with 32 bit microcontroller is used to gather data from 8 switch port sensor and sent through local wifi to a central server. ioCare IoT module has on board wifi module with 32 bit risc microcontroller.

SYSTEM ARCHITECTURE



Technologies used:

1. IoCare IOT Microcontroller :

Arduino is an open-source computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control the physical world. Why use Arduino instead of any other boards Arduino has a large development community. A large number of shields are available for adding extended functionality. Flexibility - Arduino boards are available in different sizes and capacity. Low cost and Reliable.

Our IOT Module is Arduino based however it is customized. We have added a wifi shield inbuilt. . ioCare IoT Module with 32 bit microcontroller is used to gather data from 8 switch port sensor and sent through local wifi to a central server. ioCare IoT module has on board wifi module with 32 bit risc microcontroller.

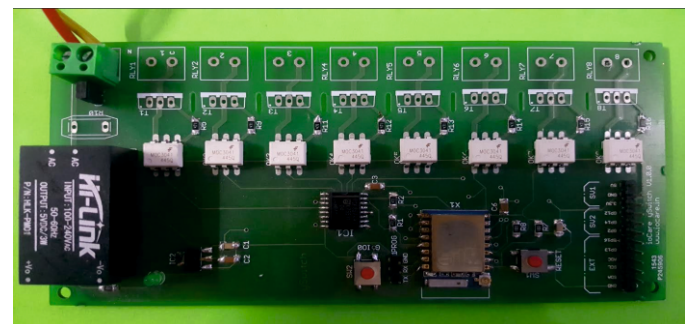


Fig. IOT Microprocessor Module by IoCare

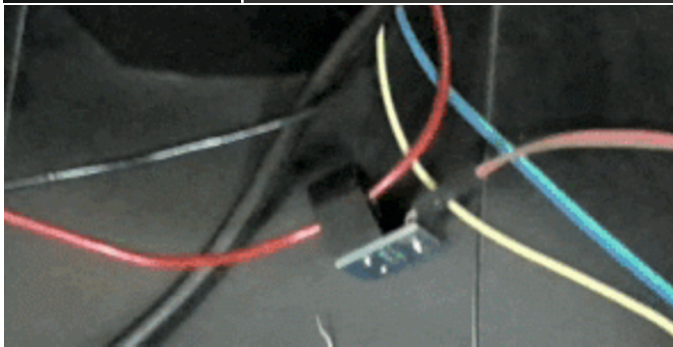


Fig. Current sensor connected to a live wire

2. Cloud Server:

We need to store all the data collected by the electricity meter and sensors into a central server and host it on the internet so that this data can be accessed remotely via a mobile application. The server program would business logic to analyze the sensor data and electricity meter and take decisions which could be communicated to mobile app. It would also receive requests from mobile app to control different electronic switches or give commands to appropriate actuators to perform certain actions.

The name of our cloud server is scare.iocare.in. The screenshots of our power monitor software are shown below

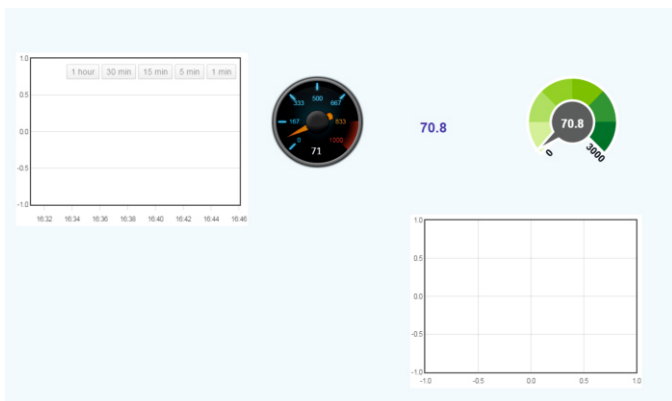


Fig. Dashboard consisting of real time graphical and analog readings. Per hour/min basis

3. Mobile Programming:

We would create a mobile application (Android) through which we can control various devices connected to arduino minicomputer remotely, as well see the messages, alerts sent by the cloud server. Descriptive and graphical information of cost and consumption of electricity can be seen in the app.

This Application will be responsible for communication from gateway through Wi-Fi. First it will ask for login and password so that unauthorized user wont be able to use it. Then it will send command for specific data as required by user and then it will display the data send by gateway in different form. There are various Buttons for various types of data to be displayed, on each click a specific command will be sent so that gateway will recognize that which data to be sent to user from Database. This meter is smart in the sense that we can set a limit of energy consumption in the application the meter will send that limit to gateway, gateway will keep track of energy consumption.

4. Communication Technology:

We would use WIFI technology to communicate between Iocare IOT Microcontroller and sensors / actuators and also between Mobile App and Cloud Server.

PROJECT PLANNING

1. Feasibility :

The sensors which will be used for sub-metering are available at a very low cost in the market and on mass order/ mass production the cost factor will even get better for far-fetched reduced cost. The IoT module along with 32 bit RISC microcontroller which is the central component of our project costs around Rs. 3000. And with even some more customization on microcontrollers ie. By discarding unwanted pins and shields, the cost can be further brought down. So as per the concern of feasibility, the entire project is made with the cheapest possible components without compromising the quality which will be delivered to the users.

2. Requirements :

The project will give it's best possible outcome when it will be clubbed with Home Automation System, bringing Home Automation System on the requirement list but as an option. The rest requirements are:

1. Current sensor connected to a live wire
2. ioCare IoT Module with 32 bit microcontroller
3. Wifi shield for processor
4. Cloud server
5. Mobile App.
6. Additional sensors as per use.

3. Verification:

The project itself is made to give correct statistical information about electrical consumption and costing. The verification can be done easily by comparing the conventional meter's current reading with reading shown by the mobile app. Also the savings can be verified by comparing past months electricity bills.

4. Implementation:

The project being at the research stage, first we aim to implement it for a small area of the Computer department of our college. But from future aspect, the smart power management and analysis system can be deployed at every house, institutions and industries because of its simplistic use and eventual resultant savings.

5. Maintenance :

The only thing to look after in this project from maintenance point of view is the replacement of sensors, since they have their own lifetime which is a very minor issue and can be done within negligible cost.

WORK PLAN

June, 2015 - July, 2015	<ol style="list-style-type: none"> 1. Studying Internet Of Things. 2. Finalizing the topic
July, 2015 - August, 2015	<ol style="list-style-type: none"> 1. Deciding the topic in the domain of Internet Of Things. 2. Searching for relevant IEEE papers for the project topics. 3. Presentations on the selected topics for approval.
August, 2015 - September, 2015	<ol style="list-style-type: none"> 1. Literature Survey 2. Synopsis Preparation
September, 2015 - November, 2015	<ol style="list-style-type: none"> 1. Designing the architecture. 2. Collecting relevant information, hardware (IEEE papers and study material) for implementation of the project.
December, 2015 - March, 2015	<ol style="list-style-type: none"> 1. Assembling the hardware. 2. Developing a smartphone application. 3. Data Analysis.

NOVELTY & INNOVATION

We are developing a device which will monitor the electricity consumption of our own campus. The electricity consumption will be shown on our smartphone in form of graphs / meters as well as numeric form. None of the existing system has given us real time analytical values of the power consumed at little interval of time (per hour / per min). We will further show readings in various time zones like active (heavy usage) moderate usage or passive (low usage). Divided time zones will help us in determining the benchmark power that should be provided in that particular time frame to help power saving.

From application single-user perspective: The only application where one can see the current as well as future predicted power usage and billing in a comprehensive fashion.

From mass/institute-user perspective: A convenient application to manage unnecessary wastage of electricity as well optimizing its usage consequently saving the electricity bill by 30%

The microcontroller is custom-made which is better than the existing microcontrollers (Arduino, Beaglebone etc) because of its on-chip wifi shield and multiple serial ports enhancing its functionality and performance but also reducing its electricity usage

CONCLUSION

Increasing the energy consumption awareness in a workplace is an important step to make the user able to manage his energy consumption. We have brought this concept even one step further by allowing users to observe not only the over-all electricity consumption but also each device's consumption. Thus users are able to learn the energy profile of each device and to identify the devices that consume most power at home.\

Based on this knowledge, users have the possibility to develop better strategies for saving energy costs. As smart homes become even smarter, systems could learn over the time and calculate the most efficient ways to configure the home appliance or to provide users with recommendations on how to save energy. Besides the technical challenges, it is necessary to keep in mind the users' requirements. A smart home application has to be developed in a user centric way and must not be purely technology-driven. It is a thin line between an effective, user - supporting home automation system and an annoying, overly intrusive one. Now, after having a running prototype we will shift focus to user evaluations, to gain deeper knowledge on how to design energy efficient smart homes. We also applied novel interaction techniques, which allow users to use their mobile phones as magic lenses to view the energy consumption of their appliances just by pointing gestures. When users require more details or when they like to compare energy consumption between devices, they can easily transfer the information to a larger display such as a TV.\

Future Scope of this project will be to combine our Power monitoring application along with Home automation to allow complete control over all the appliances while monitoring their power consumption.